Discovery

Effect of Swali abattoir activities on the pollutants level of Ekole River of Swali-Yenegoa in relation to water quality standards

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ABSTRACT

Pollutants are hazardous to human health and environments, in view of this, the research investigated the effect of Swali abattoir activities on the pollutants level of Ekole river of Swali-Yenegoa in relation to water quality standards, and provided a spatial analytical framework for sustainable urban environmental management, through analysis of physicochemical parameters and the heavy metals characterization and statistical investigation in relationship with the standard was done using AVONA within MATLAB 2020B. The average values of the results for physicochemical parameters which includes; pH, electrical conductivity, temperature, sulphate, bicarbonate, dissolve oxygen, BOD, phosphate, Alkalinity and Acidity for Point B mean values are higher than Point B, while the mean values of heavy metals in the samples of Point A including iron, lead, cadmium, magnesium and chromium are higher than Point B. The finding revealed that all the physiochemical parameters and all the heavy metals investigated were above the recommended value of FEPA and WHO for potable water. The p value was significant at 6.2×10^{-14} for point 'A' while at point 'B' it was at 2.58102×10^{-7}which are quite lower than 0.05level significant tested.

Keywords: Abattoir, Wastes, Pollutants, Heavy Metals, Physicochemical parameters

1. INTRODUCTION

Water is critical for survival of living entities; this involves the surface and the sub-surface. The Surface water is significant because it is intensively use for domestic and industrial purposes. However, surface water is considered to have more microbial quality, because it is directly expose to sewage, indiscriminate dumping of refuse, several animal waste dump, waste from abattoir activities such as washing of the slabs and meat that is eventually drained into water, which is connected to shallow aquifers that makes it to be more susceptible to microbial pollution and inorganic

pollution that has reportedly killed few numbers of people who largely depend on surface water. The pollution of the surface water in Swali is inevitable because the Swali abattior is located in near Ekoli River.

Swali is popular community in Yenegoa, because it hosts a popular daily market in Bayelsa State, with ever growing population and industries around Ekoli river which the dwellers depend on directly or indirectly for survival. The amount of impurities discharged into the river through the household, abattoir and industrial waste make the water not to be potable and when use as potable water will affect the hygiene of people that depend on it; this can result in health hazards such as acidiosis, gene mutation, diarrhea, cholera, cancers, yellow fever, typhoid, mental and skin disorders, just to mention a view, according to FEPA over a thousand diseases can result from the polluted water activities. Moreover, pollutants such as heavy metals like zinc, chromium, lead, iron and cadmium can also affect the health of the people living around if the water is consumed without proper purification.

Hence the need to ensure the water quality that humans consumed is very important and must be very intense, so every programme for human development must ensure a readily available supply of quality water (Fashola et al., 2013). This inform the analysis of the Ekoli water pollution level being brought about by the abattoir activities particularly and determine it deviation from universally acceptable water quality. Though, Abattoir industry is vital constituent of livestock industry because it makes domestic meat available for millions of people (Markmanuel et al., 2023) and provides employment opportunities for a huge number of people in Nigeria, but some abattoir sites whose activities are otherwise not monitored and regulated as expected can be dangerous to the health of people. These activities include slaughtering of cattle, skinning, trimming, intestine management, butchering, cleaning, disposal of waste and other processing activities that make meat available.

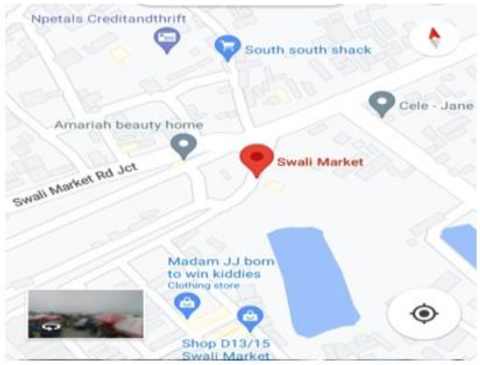
These activities generate wastes like blood, oil, organic solids, mineral salts and chemicals added during handling operations, which are discharge into the streams or rivers through drains. These wastes according to Magaji and Chup, (2012) are often separated into solid, liquid and fats. The solid consist of; condensed meat, undigested ingest, bones, hairs, and aborted fetuses, the liquid includes; dissolved solids, blood, guts contents, urine, and water, while fat content is basically; fat and oil. The abattoir effluents, runoff from feedlot, in dairy farms, grazed pastures, grassland treated with dairy manure and sewage sludge leads to water bodies' contamination and could create significant environmental and public health hazards (Wanjohi et al., 2022). Abattoir wastewater could intensify significantly the amount of nitrogen, phosphorus and total solids in the receiving water bodies. The residents close to the abattoir site in Swali community who depend on Ekoli River are prone to water and air pollution resulting from the abattoir activities.

This pollution results in the destruction of primary producers, thereby reduce the survival of aquatic animals and reduction in their yields, more importantly it results decreased in diet Aina and Adedipe, (1991), hence water bore diseases. Therefore, the quality of the Ekoli water with and without abattoir effluents contamination will be investigated using Water Quality Standards of World Health Organization and FEPA to ascertain deviations from the standard requirements of some physicochemical parameters and heavy metals analyzed in the laboratory for portable water. This research aimed at determining the contamination level of surface water around abattoir where abattoir effluent are discharged in Swali market Yenagoa, Bayelsa State, by considering; the physicochemical parameters and the heavy metals in Ekoli River, and abattoir waste impacted on water quality, the contaminant level of metals in water and compare them with WHO standard, there after validate using a multi-statistical tool.

2. MATERIALS AND METHODS

Study Area

Swali community constitutes the area of study and it is located in Yenagoa the local government of Bayelsa State (Figure 2.1). Yenagoa is located at latitude of 4°55'16.18"N and a longitude of 6°16'29.18"E. Swali is a major town in the local council area with geographical area of 706 km² and a population of 353,344 at the 2006 census. The area of study lies South South region of Nigeria where there is high rainfall. The mean monthly temperature is 32°C. The residents of the community are; fishermen, civil servants, traders, students, and artisans by occupation. The sites of the experiment were geo-referenced using a hand-held global positioning system GPS (Megallan GPS 315) which generated geographical coordinates of latitude 4° 54′ 52″N and longitude of 6° 15′ 57″E of the river. The Ekole river which passes through Swali as shown in figure 2.2 having the water depth of 4.8m, which is tidal and gradually transits from fresh to salt water at the head. The river is the main source of water for abattoir activities which started within the watershed (Figure 2.3). Nearby clay open channel receives the drained wastewater, into the river, and heap of bones and cow dung is seen close to the river bank.



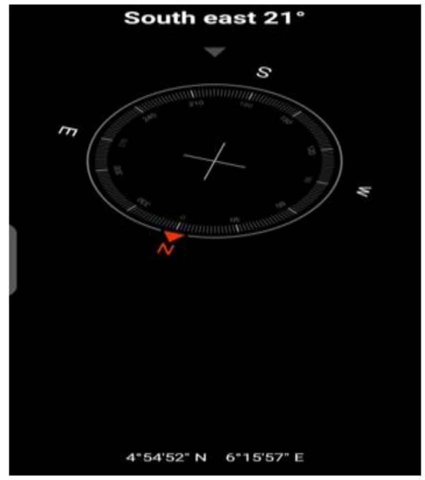


Figure 2.1: Map of Bayelsa showing the study area Figure 2.2 Source Compass: location of Swali

Figure 2.3: Abattoir sites showing the activities and the blood spills on the slab

Sample collection

The sample was collected for the duration of 120hours at an interval of 24hours at which is between 7am to 8 am daily, making it possible to have six collections within the duration of the experiment. There are two (2) collection points labeled A and B along the stream at; upstream with where six (6) control samples were collected and downstream where six (6) experimental samples collected for both Point A and Point B respectively. The Point A being the entrance of waste materials from abattoir into river is at 5 m distance to the bank of the river, while point B is 50 m from points A which serves as control point. Point A and Point B have the coordinate reference of Latitude 4°57′31″N, Longitude 6°55′23″E and Latitude: 4°54′52′′N Longitude 6°15′57′′E respectively.

The systematic sampling was applied to collect water samples from two points in March 2022. At the time which is 7am to 8 am the effluents from the abattoir were already in contact with water of the river. The total samples collected were twelve (12) from both points. At every point of collection, the clean sterilized 250ml amber bottle appropriately labeled, which is preserved in 5% v/v nitric acid was used for same collection of water. The thoroughly washed with deionized water before use. Nitric acid was added at quantity of 10ml, thereafter was placed in a cooler which contains ice pack, to retain its originality. The temperature and pH of water samples collected were immediately taken using mercury bulb thermometer and pH indicator strip, then the samples were taken to the

laboratory for analysis of pH, temperature, electrical conductivity, Sulphate, magnesium, dissolve oxygen, iron, lead, Cadium, and Chromium.

Laboratory Analysis

Physicochemical tests were conducted on the collected samples in the laboratory for the following parameters: pH, temperature, electrical conductivity, Sulphate, bicarbonate, dissolved oxygen (DO), 5-day biochemical oxygen demand (BOD5), alkalinity and acidity, BOD and COD are known to be indicators of organic pollution in water. The water samples were also tested for the following heavy metals: iron, lead, cadmium, magnesium and chromium. The physiochemical quality was determined using the American Public Health Association APHA standard methods. while the heavy metal analysis was carried out using hydrochloric acid digestion and atomic absorption spectrometer metal ion concentration were determined (model Philips PU 9100) with a hollow cathode lamp and the Fuel rich flame (air acetylene) the chromium, cobalt, cadmium, iron, and lead at the parameters analyzed.

Statistical Analysis of Data Using MATLAB

In line with the research objectives, appropriate statistical method like ANOVA, was use in comparison of collected data to statistically investigation the relationship with the sampling point. One-way ANOVA within MATLAB 2020B was used to ascertain significant variations of parameters within different sites of the Ekole River. The ANOVA was used to represent the relationship between heavy metal tested and physicochemical parameters of the river within different sites of the river. Probability was set at $P = 0.5$)

3 RESULTS AND DISCUSSION

Comparison of Physiochemical Parameters with WHO and FEPA Standards

pH Value

As reflected in Table 1, the pH values of the samples ranged from 7.0 to 8.2; with average pH of 7.3 at Point A and, 7.9 at Point B, meaning the abattoir sewage increased the pH of the river. The average at both points is within the acceptable limits of, also, the pH of 8.2 recorded for the sample taken at 96hrs of Point B is within world health organization WHO, (2017) maximum allowable levels, which recommended range of pH values (6.5- 8.5) for even drinking water (WHO, 2011). However, such pH at 8.2 could lead to eutrophication or nutrient enrichment with its attendant disastrous consequences. For instance, the addition of inorganic or organic matter which includes the abattoir sewage tends to increase the oxygen-consuming effect on rivers, which limit penetration of sunlight and a consequent reduction in the growth of planktons. The peak values were experienced as a result of the increase in algae populations by their photosynthetic activity which increases the number of hydroxyl ions.

Table 1 Physiochemical Parameters of Ekole River water sampled at Point A and Point B

	Physiochemical Parameters									
Point A	*Time*	*pH*	*Condu*	*Temp.*	*SO4*	*HCO3*	*DO*	*BOD5*	*Alkaline*	*Acidity*
	0	7.2	76	27	514.98	0.7	4.2	1.8	125	75
	24	7.5	72	28	415.9	0.6	1	1.8	180	80
	48	7.7	52	26	455	0.5	2	2	180	90
	96	7.9	60	27	678.4	0.3	2.5	1.9	100	60
	120	7.7	70	26	785.3	0.5	3	1.6	125	200
	Mean value	7.6	66	26.8	569.92	0.52	2.54	1.82	142	101
Point B										
	0	7.3	588	30	343.32	0.2	5.1	4.7	200	75
	24	7.1	269	31	514.98	0.2	1.2	2	500	100
	48	8	61	28	514.96	0.2	5	2.7	500	125
	72	8.1	80	30	1886.2	0.3	5.8	3.9	125	50

	96	8.2	86	29	858.3	0.5	4.9	1.7	175	575
	120	7	583	29	898.3	0.3	5	4.2	180	70
	Mean value	7.617	277.8	29.5	836.01	0.283	4.5	3.2	280	165.833

Note: All parameters are in mg/L expected Time in hrs, Conductivity in µm cm-1 Temp in 0C., pH Acidity and Alkaline no unit

Table 2 The deviations of some physiochemical parameters from the WHO and FEPA standards

PARAMETER	MEAN VALUE		STANDARD		WHO DEVIATION		FEPA DEVIATION	
	POINT A	POINT B	WHO	FEPA	POINT A	POINT B	POINT A	POINT B
PH	7.8	7.612	6.5	8.5	-1.3	-1.112	0.7	0.888
CONDUCTIVITY	66	278	1000	1000	934	722	934	722
TEMPERATURE	26.8	29.5	<40	<40	13.2	10.5	13.2	10.5
SULPHATE	569.9	836	250	20	-319.9	-586	-549.9	-816
HCO3	0.52	0.28	250	45	249.48	249.72	44.48	44.72
DO	2.54	4.5	5	7.5	2.46	0.5	4.96	3
BOD5	1.82	3.2	5	30	3.18	1.8	28.18	26.8

Note: All parameters are in mg/L expected Conductivity in µm cm-1, Temp in 0C., pH Acidity and Alkaline no unit

Electrical Conductivity

The electrical conductivity of the samples in Table 1, ranged from 60µm cm-1 at 96hrs in point A to 588µm cm-1 at 0hr in point B. The Point A has the low value for electrical conductivity with an average of 66 µm cm-1, while the average conductivity Point B where the abattoir waste is discharged into Ekole River is higher at 277.8 µm cm-1. This clearly indicates that there is a build-up of electrical conductivity at the point the waste enters the river. It is noted that abattoir waste increases the electrical conductivity of the water. The values presented at Table 1 are well above the limits of 3.0µm cm-1 recommended by FAO for water used for agricultural purposes such as irrigation. This means the higher conductivity of Ekole River and the highest at point A and point B respectively make it unfit for agricultural purposes

Temperature

The temperature of the samples ranged from 27 to 31°C, the temperature of the samples at Point A and Point B sections were within than WHO recommended standards but were lower than the FEPA, values of 35-40°C. High temperature causes thermal pollution and adversely affects aquatic life.

Sulphate

The Sulphate (SO_4) of the samples ranged from 343.32 to 1886.20mg/L, with an average of 569.92mg/L for point A and 836.01mg/L for point B in Table 1, revealing that the effluents from the abattoir activities increases the Surphate level of the river. In either case of the Sulphates levels, the effluents are allowed by FEPA to be used for irrigation purposes if the Sulphate content is equal to 500mg/L. Therefore, result satisfies the criterion for use of the effluent from the abattoir as irrigation water, because the Sulphur found in Sulphates is important for plants in the formation of specified proteins in the protoplasm.

Bicarbonate

The Bicarbonate (HCO_3) of the samples ranged from 0.2 mg/L at 0hr, 24hr and 72hr in point B to 0.7 mg/L at 0hr in point B. The Point B has the lower value bicarbonate with an average of 0.283 mg/L while the Point A without the abattoir waste is discharged is higher at 0.52 mg/L that means bicarbonate is reduced by the effluents, as seen in (Table 1).

Dissolved Oxygen

The highest Oxygen (DO) which is 5.8 obtained in Table 1 at 72hr is a taken from Point A while the lowers in Point B at 24hr. The DO of Point A is lower to that of Point B considering the following averages 2.54 mg/L and 4.5 mg/L which are for the points of collection respectively. This means the Ekole River at the location of the study can be useful as these ranges are in conformity either the FEPA or WHO that provide maximum allowable at

Biochemical Oxygen Demand

The Biochemical Oxygen Demand (BOD5) the samples ranged from 1.6 mg/L to 4.7mg/L collected at Point A and Point B at 120hr and 0hr respectively, the mean value of the BOD5mg/L at point B is higher than Point A due to the abattoir contaminant in the water body. These figures are higher than WHO recommended standards, but are lower than the FEPA's value as reflected in (Table 2).

Alkalinity

In Table 1, the Alkalinity of the samples ranged from 100 to 500, at 96hrs in point A and 24 and 48hrs in Point B. The Point A has the low value for alkaline at an average of 142 mg/L, while its average at Point B where the abattoir waste is discharged into Ekole River is higher at 280 mg/L. There is no FEPA and WHO allowable limit for this chemical parameter.

Acidity

The acidity of the samples collected are from 60mg/L to 575mg/L both at 96hr of point A and Point B respectively as seen in (Table 1). The acid content of downstream (Point B) is higher because of the discharged effluents of abattoir than the upstream where there not such discharge meaning the discharged effluents of abattoir causes an increase in the acidic level of the water. This is equally applicable to alkalinity The study shown in Table 1 that the mean values of the physiochemical parameters of the Ekole Rivers which include pH, electrical conductivity, temperature, DO, BDO, alkalinity and acidity is higher in Point B – the downstream except the HC03 than Point A- upstream except the HC03 which is low. This because of the presence of the abattoir effluent that is disgorged into the river as a result of the abattoir activities in the area. Placing values in the standards of WHO and FEBA, some parameter with the permissible range for specific use, while some are not.

A further detail was also provided in Table 2 specifying sulphate as a parameter that is not permissible standards for domestic water usage. The levels of some physiochemical parameters of the river as touching its pollutant as compared to WHO and FEPA standards, shown in Table 3, revealed in their deviations for both WHO and FEPA for the samples collected for points A and B. The table shows that most parameters captured are lower than the standards given their positive values, except for Sulphate which is higher when compared with both standards. The inference is that Sulphate is a significant pollutant in Ekole River because it is generally higher than the required standards at both points of experiments. Furthermore, after the discharge of the abattoir waste, the water became more contaminated with sulphate as seen in Table 3, where point B of both standards have higher negative values as compared to Point A. Therefor more sulphate is identified with abattoir effluents.

Table 3 Heavy Metals of Ekole River water sampled at Point A and Point B

		HEAVY METAL				
Point A	Time	*Fe*	*Pb*	*Cd*	*Mg*	*Cr*
	0	5.95	0.03	0.89	1.01	0.66
	24	5.85	0.02	0.75	1	0.62
	48	3.8	0.02	0.8	0.95	0.6
	96	4.92	0.02	0.6	1.11	0.58
	120	5.9	0.02	0.69	1.01	0.66
	Mean Value	5.284	0.022	0.746	1.016	0.624
Point B						
	0	5.23	0.08	0.44	2.22	0.26
	24	2.37	0.1	0.02	1.64	1.001

	48	4.35	0	0.01	1.13	1.59
	72	4.19	0.05	0.08	1.19	0.39
	96	4.94	0.01	0.12	1.37	0.41
	120	4.87	0.03	0.1	1.68	0.16
	Mean Value	4.325	0.045	0.128	1.538	0.6352

Note: All parameters are in mg/L

Table 4 The deviations of heavy metals from the WHO and FEPA standards

HEAVY METALS	MEAN VALUE		STANDARD		WHO DEVIATION		FEPA DEVIATION	
	POINT A	POINT B	WHO	FEBA	POINT A	POINT B	POINT A	POINT B
IRON	5.284	4.325	0.015	0.3	-5.269	-4.31	-4.984	-4.025
LEAD	0.022	0.045	0.01	0.01	-0.012	-0.035	-0.012	-0.035
CADMIUM	0.746	0.13	0.003	0.01	-0.743	-0.127	-0.736	-0.120
MAGNESIUM	1.016	1.538	0.1	0.1	-0.916	-1.438	-0.916	-1.438
CHROMIUM	0.624	0.635	0.05	-	-0.574	-0.585	-	-

Note: All parameters are in mg/L

Comparison of Heavy Metals with WHO and FEPA Standards

Iron

In Table 3 the following were deduced; the average concentration of iron (Fe) in Point A is higher than the average value in Point B which are 5.284 mg/L and 4.325mg/L respectively. The result of the research shows that all the samples fall within the acceptable limits of FEPA but they all exceed the acceptable limits for WHO, (2011) having the acceptable limit of 0.30 mg/L.

Lead

The average concentration of lead in all the samples is 0.045 mg/L at Point B which higher than 0.022mg/L at point A as detailed in (Table 3). This may due to the presence of lead in the rumen contents of cows that grazed along the high ways which are discharged into the river during the abattoir activities. An earlier study found that lead compounds were present in high concentrations in grasses and shrubs that grew along the highways (refer) from Table 3 it was deduce that lead is higher when compare with WHO and FEPA.

Chromium

The value for the chromium ranged between (0.01 and 1.00) mg/L in Table 3, which are lowest and highest concentration gotten from Point B. However, the same collection point has high average of 0.6352mg/L in comparison with point A having the average value of 0.624mg/L. The values were above the WHO permissible limits of 0.05 mg/L in (Table 4). The intake of such values is harmful to human; Chromium harmfulness includes liver necrosis and membrane ulcers.

Magnesium

In Table 2: The Magnesium (Ma) concentration of sampled Ekole River ranges from 0.95mg/L at 0hr to2.22mg/L at 24hr, while the average concentration of magnesium in all the samples is 1.538 mg/L at Point B which is higher than 1.016mg/L at point A, as indicated in (Table 3). This shows the impact of abattoir waste discharge into the river, this not without benefits as, it has been is reported that magnesium concentration with calcium give the water a very high buffer capacity against acid input, especially in the formation of acid from the nitrification of ammonium (Udom and Nwankwoala, 2018).

Cadmium

The concentration of cadmium of samples collected at Point A (where there is no abattoir effluents) has higher with a mean value of 0.746 mg/L than the mean value of the samples in Point B which is 0.128 mg/L both of which are not permissible for use when compare to WHO and FEPA standard which are 0.003 and 0.01 respectively on (Table 4). In Table 3 and 4, mean values of heavy metals in the

samples collect at Point A including iron, lead, cadmium, magnesium and chromium are higher than Point B except iron lead that are lower.

The mean values of the heavy metals tested in Ekole River in relation to its contamination levels as compared to WHO and FEPA standards, shown in Table 4, which detailed their deviations for both WHO and FEPA for the samples collected at points A and B. The table shows that all the heavy metals captured to determine the pollutant level of Ekole River are higher than the standards given their positive values at both samples at points A, meaning all the heavy metal tested are significant pollutants in Ekole River because their levels were higher in the water than the required standards at both points of experiments. Meanwhile there are variations in the aviation of the mean values of all the heavy metals as detailed in Table 4, after the discharge of the abattoir waste, depending on the standard of both WHO and FEPA.

The ANOVA Presentation of Pollutant

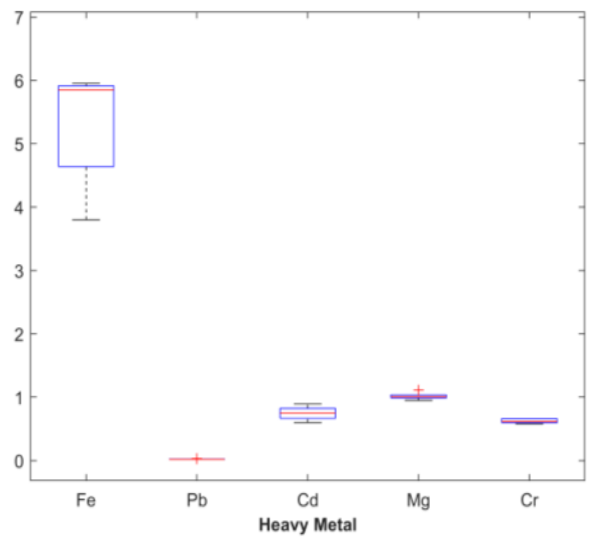


Figure 3.1 Heavy metal sampled at Point A Upstream

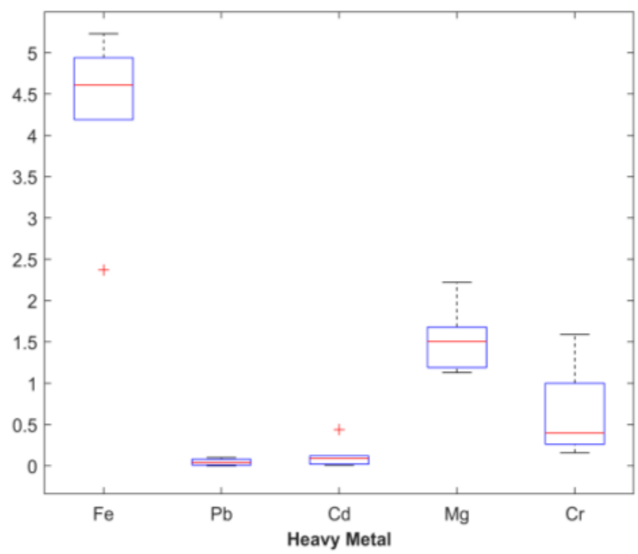


Figure 3.2 Heavy metals sampled at Point B Downstream

From the ANOVA comparison of heavy metals study on MATLAB 2020B it was deduced that the significant level is at 6.2×10^{-14} for point 'A' while at point 'B' it was at 2.58102×10^{-7}which are quite lower than 0.05 significant level considered, meaning there are no significant changes in measured heavy metal contaminant over time (Figures 3.1 & 3.2). Since the P-value is less than 0.05 we reject the null hypothesis and conclude that there is no significant difference in collected samples or the data collected is not sufficient to deduce significant level.

4. CONCLUSION

The appearance of the abattoir at Swali market is of public health concern, as the study indicates that activities of the urban abattoir had contributed to the pollution of the river by distorting the physicochemical and biological characteristics of the river. The high values of measured metals which ranges from (5.284-0.01) mg/L which is above FEPA and WHO standers shows that the water is not portable for use, though from the ANOVA analysis, it was observed that there are no significant due to insufficient data, it can still be deduced from physicochemical and biological characteristics unfit for use by dwellers around the study area. It was also noted that most contaminant or pollutants increased at the point of discharge of the abattoir waste, hence the study recommend the use of effluent treatment plant at abattoir site and an environmental impact of the abattoir at regular interval.

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Informed consent
Not applicable.

Ethical approval
Not applicable.

Conflicts of interests
The authors declare that there are no conflicts of interests.

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Data and materials availability
All data associated with this study are present in the paper.

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